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The Northern Cities Shift in the Heartland? A Study of Radio Speech in Columbus, Ohio*

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Abstract: Variation in vowel height and diphthongal/monophthongal character of the vowels /æ/ and /a/ are studied in the speech of two speakers from central Ohio in order to measure their participation in the sequence of vowel system changes commonly referred to as the Northern Cities Shift (Labov, 1994). The data were gathered from radio shows for which the speakers served as announcers. Determinations of vowel height and diphthongal nature of vowels were made by auditory judgment of the researchers and were correlated with acoustic measurements of *F1* and *F2* frequencies. The results suggest that the vowel system of the central Ohio dialect is undergoing change, but are inconclusive as to whether this change indicates participation in the Northern Cities Shift. Detailed analyses of social and linguistic factors correlated with the tensing and raising of /æ/ are offered.

INTRODUCTION

Recent research in American dialectology has focused on differences in vowel systems as a means for differentiating regional dialects (e.g., Labov, 1991). It has been demonstrated, for example, that the dialects of the southern states can be characterized by a raising and tensing of front, lax vowels and a concomitant lowering and laxing of front, tense vowels along with a somewhat fronted production of back vowels. This collection of

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shifts in vowel quality with respect to Standard American English (SAE) has been dubbed the Southern Vowel Shift (see Figure 1).

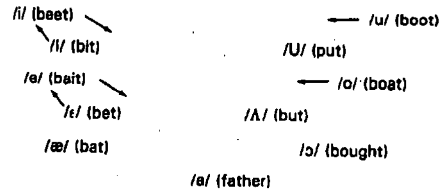

Figure 1. Vowel rotation in the Southern Vowel Shift (adapted from Wolfram, 1991:87).

A number of recent studies have focused on a separate shift in the vowel systems of dialects spoken in certain urban areas of the northern United States, including Rochester, New York; Buffalo; Detroit; and Chicago, among others (Eckert & McConnell-Ginet, 1995; Gordon, 1996; Labov, 1991, 1996). Many Euro-American English speakers in these cities produce short, or tense, vowels that are markedly different from their SAE counterparts: /æ/ is raised and tensed, /a/ is fronted, /ɔ/ is lowered and slightly fronted, /ɪ/ is lowered, /ɛ/ is produced more centrally, and /ʌ/ is backed (as is shown in Figure 2). This set of shifts is generally referred to as the Northern Cities Chain Shift, or Northern Cities Shift (NCS).

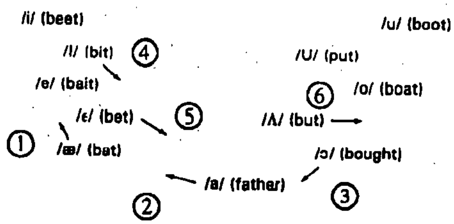

Figure 2. Vowel rotation in the Northern Cities Shift (adapted from Wolfram, 1991:87). Circled numbers are added to indicate the ordering of vowel movements, with "1" occurring first and the others following in order (Labov, 1994:195).[2]

These movements in the vowel space are not random. The vowel space appears to act as a connected system. As speakers' production of a given vowel shifts, the shifted vowel both impinges on the phonetic space occupied by other vowels and leaves behind a void in the phonetic space for another vowel to move into. This can result in the collapsing

[2] The ordering of the final three changes has not been conclusively determined. Labov (1996), e.g., posits that /ɛ/→/ʌ/ is "4," /ʌ/→/ɔ/ is "5," and the centralization of /ɪ/ is "6."

of what were once two vowel phonemes into one, or it can "push" or "pull" adjacent vowels to move as though they were linked by a chain; thus, the term "chain shift." Hock & Joseph (1996:134) note that chain shifts are conditioned not only by purely phonetic factors, but are responsive to abstract cognitive structure as well. This seems plausible for any but the initial shift.

The Northern Cities Shift has been touted as "a massive change that bears no resemblance to any chain shift previously recorded in the history of the [English] language" (Labov, 1994:10). What is more, it is a chain shift in progress across temporal and geographical space, as demonstrated by the fact that some speakers (often younger urbanites) produce shifted variants for all of the vowels in question, while other speakers (often older ruralites) shift only some of the vowels. Further studies indicate that the shift is spreading to surrounding rural areas in the north (Gordon, 1996; Ito, 1996).

Although the northern Ohio cities of Cleveland and Toledo participate in the NCS, no such chain shift phenomenon is claimed to be diagnostic of the dialects of central Ohioans[3]. In most dialectology maps, the region surrounding the capital, Columbus, is classified as "lower north" or "midland" (see, e.g., Wolfram, 1991:83-5). However, Ohio as a whole, and central Ohio in particular, have been largely ignored in dialect studies, leaving a gap in our knowledge about the dialect(s) of the millions of speakers who inhabit this area. For these reasons, Labov has characterized this area as "the mysterious midlands" (Labov, p.c.).

The goal of this paper is to take a small step toward closing this knowledge gap. Specifically, given the apparent vitality of the NCS and our position as researchers located in a major urban area[4] adjacent to the traditional northern dialect region, we raise the following questions: to what extent is the NCS making inroads in the speech of central Ohio speakers? And to what extent are individual vowel shifts in central Ohio conditioned by internal and external factors? This paper is a preliminary report of this work in progress.

METHODS

In this pilot study, we limit the number of dependent variables to just two of a possible six vowel shifts in the NCS, and utilize an uncommon method of data collection: recording radio speech. As will be discussed below, due to the small subject pool and limited stylistic variation in the data, certain aspects of our socio-stylistic analysis can only be considered preliminary.

Included in this section are the following subsections: "Selection of Dependent Variables," "The Corpus: Radio Speech," "Selection of Speakers," "Data Collection," "Analysis for the Tensing and Raising of /æ/: Scale Development and Scale Validation," "Vowel Spaces and the Interaction of Height and Tenseness of /æ/," "Selection of Indpendent Variables for the Study of /æ/ Variation," and finally, "Statistical Methods."

Selection of Dependent Variables

Of the six different vowel shifts which together make up the NCS, the present project is confined to only two shifts (our dependent variables): the tensing and raising of /æ/, and the fronting of /a/.

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3 It should be noted that the term "central Ohio" can be used to refer to a rather large area of several dozen counties with a heterogeneous populace. Given this imprecise definition of "central Ohio," it is possible to say that certain aspects of the Southern Shift are present in the speech of some central Ohioans (e.g., *fish* as [fiʃ], but possibly conditioned by the following palatal segment).

4 The population of the greater Columbus metropolitan area is 1.35 million, according to the 1990 census.

We would expect speakers from Columbus—an urban area which neighbors the northern dialect region—to either exhibit none of the NCS shifts, or only the initial shifts in the chain. This requires an investigation into the relative chronology of the NCS.

A temporal ordering of the vowel shifts in the NCS places the raising of /æ/ as the first shift to take place (the circled numbers in Figure 2 indicate the order in which the vowel movements are taking place). This shift appears to be nearing completion in many communities where the NCS is active. Selecting /æ/ as the sole dependent variable, however, would not provide conclusive evidence of the NCS, given the volatile nature of /æ/ in American English. For example, the raising of /æ/ can also be found in many southern varieties of American English.

Therefore, a second shift, the fronting of /a/, is examined in conjunction with the raising of /æ/. While the raising of /æ/ is not unique to the NCS, the fronting of /a/ is.[5] This shift is chronologically second in the chain, and is considered to be a change in mid-course. These two shifts can be seen as functioning as a pull or drag chain, with the movement of /æ/ clearing the phonetic space into which /a/ can then move (Labov, 1994:195). Alternatively, we might wonder whether this second shift is feeding into the first, so that tokens of /a/ are shifted to /æ/ and then raised, resulting in the elimination of all low vowels. The fact that the tensing and raising of /æ/ is nearing completion in northern cities, whereas the fronting of /a/ is a much more recent phenomenon, makes this an unlikely scenario.

We selected these two vowels, /æ/ and /a/, involved in the initial shifts in the NCS, as our dependent variables. Taken together, these two vowels should provide a clear indication of the presence or absence of NCS-like shifting in the speech of central Ohioans.

The Corpus: Radio Speech

We wanted a reasonable way to record large samples of speech for phonetic analysis. We decided to gather data from local radio on-air personalities, a method which has been successfully employed by other researchers (Bell, 1984; Van de Velde & van Hout, 1996; Van de Velde, et al., 1996).

First, we identified two radio stations which can be reasonably claimed to differ in the demographics of their listener base. One station plays an all-classical music format and the other plays exclusively contemporary country music. Van de Velde, et al. (1996:5) state that in the selection of stations for such research, one should look for stations targeting clearly different and relatively single-layered audiences. Our idea in taking this step is that the speech of announcers on the two stations will, to some extent, reflect the speech of the audience that they target. The theoretical framework supporting this claim is Bell's work on speech style as audience design, which assumes that "persons respond mainly to other persons, that speakers take most account of hearers in designing their talk" (Bell, 1984:159).[6] There are four audience roles in Bell's theory which differ in the degree of influence that they exert on a speaker's style (listed in descending order of influence): addressee, auditor, overhearer, and eavesdropper. In radio speech, the addressees are the station's target audience. Auditors, overhearers, and eavesdroppers make up the rest of the potential listening public (177). Here we are most concerned with the audience which has

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[5] Whereas the Northern Cities dialects front /a/, certain New York City dialects raise /a/ to /o^{ə}/ or even /u^{ə}/ (Hock & Joseph, 1996:134); in the Southern Vowel Shift, /a/ is entirely stable.

[6] Labov's study of post-vocalic [r] in the speech of New York City department store personnel (1972) is an example of an application of a method similar to ours, but which predates Bell's theoretical framework. Labov identified three department stores serving clientele of demonstrably different socioeconomic statuses. The speech of clerks in each store was then interpreted as reflecting the speech of the SES of the customers they served.

the most impact on speaker style: the addressees (target audience) for each station. In short, these radio stations, and therefore the announcers employed by them (and their speech), can be considered reflections of the targeted audience and their respective socioeconomic strata in society.

One indication of the difference in listener demographics of the two stations included in our study came from a personal communication with the station manager of the classical station. In terms of a profile for the station's prototypical listener/supporter, he submitted the following description: over age 35, affluent, well-educated, "National Public Radio-type" person. This appears to fit Van de Velde's single-layer audience criterion. It is less clear how or whether the country station audience is similarly "single-layered." While we cannot conclude that the listeners of the country music station are categorically younger, poorer, and less educated than the classical station listeners, it is reasonable to assume that the classical station prototype would describe only a small subset of the listener base of the country station. We would expect, then, that on average, measures of socioeconomic status would show a difference between the audiences of the two radio stations: the classical station would represent a higher socioeconomic status, and the country station would represent a lower socioeconomic status.

A second criterion in selecting the stations was a control variable, this being that both stations aim at the same greater Columbus metropolitan area audience. Two pieces of evidence show that this "locality constraint" is satisfied with our selection of these two stations: the classical music station has an hourly Columbus traffic update, and the country station has many listeners who call in to the on-air programs and identify themselves as residents of the greater Columbus metropolitan area.

Selection of Speakers

We identified two native speakers of Central Ohio English, both of whom were radio announcers on Columbus-area stations. The speaker from the country station was an approximately 25-year-old male native of Columbus whom we will call "Red." The speaker from the classical station was a male native of Newark (30 miles east of Columbus) in his mid-forties, whom we will refer to as "Daniel." Sex of the speakers was treated as a control variable. Potential influences due to age difference are not considered here.

Data Collection

For both speakers, speech samples were recorded from the radio during their on-air shows. "Red's" show aired in the afternoon and evening and consisted of him announcing the songs to be played, as well as taking a number of calls from listeners requesting favorite songs or taking part in on-air promotions. "Daniel" was recorded during the classical station's quarterly fund-raising drive, and his participation consisted of a number of monologues touting the benefits of supporting his station, as well as some interaction with an on-air colleague.

For both speakers, two "style" levels were recorded, what we termed "monologue" and "dialogue." We used "monologue" to refer to relatively scripted talk (almost always addressed to the listening audience), and "dialogue" to refer to talk that occurred either between the announcer and listeners calling in to the station, or between the announcer and his on-air colleagues. This style variable is included to test one prediction of Bell's theory. According to Bell's design, "the mass auditors [the targeted listening audience] are likely to be more important to a communicator than the immediate addressees [the on-air collegues or listeners calling in to the station]" (Bell, 1984:177). In other words, all radio speech is addressed to the mass auditors, and so therefore there should not be a significant style difference between the monologue and dialogue situations. The opposite hypothesis is also defensible: that in dialogue, the amount of attention paid to speech will be less than that in announcement-types of speech (monologue), yielding a style difference.[7]

Analysis of Tensing and Raising of /æ/: Scale Development and Scale Validation

We made a preliminary auditory analysis of tokens of /æ/ and /a/ in the recorded data from our two speakers. This analysis revealed a high degree of variablity in the tokens of /æ/ and very little in the tokens of /a/. For this reason, we leave investigation of the possible variation in /a/ to a future study, and rather focus on the development of more refined analyses for the examination of the tensing and raising of /æ/.

We initially conducted quantitative analyses of 343 realizations of morphemes containing the segment /æ/. These analyses consisted of several steps. First, in order to code each token for its level of tensing and raising, we needed to develop scales to describe each of these characteristics. We did this by first making narrow phonetic transcriptions of 30 token types. We carefully grouped these 30 original types into several categories which allowed us to create two descriptors specifically for the purpose of describing the data in this study, a height scale and a tenseness qualifier. The former was a five-point scale for which the points were salient vowel height categories for each of the author-listeners (as is shown in Figure 3 below).

Height rating	Phonetic symbol[8]	Example word
5	ɪ	*bit*
4	e	*bait*
3	ɛ	*bet*
2	Æ[9]	
1	æ	*bat*

Figure 3. Height scale developed from our Columbus data.

We denoted the tensing (diphthongal/monophthongal) quality of the vowel as shown in Figure 4:

[7] In the Labovian definition of style, the relative amount of attention paid to speech plays a central role in the (relatively formal or informal) style of the speech (Labov, 1972:Chapt. 3).

[8] These "phonetic symbols" are generally equivalent to their IPA counterparts, with the exception of Æ, discussed in Footnote 9 below.

[9] This symbol, "Æ," which we refer to as "capital ash," represents a salient category between lower /æ/ and higher /ɛ/ for this variety. For example, the token vowel in question was compared with the vowel in each member of the minimal pair *bat* [bæt] and *bet* [bɛt]. When the vowel was perceived as neither of these—i.e., higher than the vowel in *bat* but lower than the vowel in *bet*—it was classified as /Æ/. While salient to the authors and data coders, this category is not contrastive, thus does not exist phonemically in Standard American English.

Diph. rating	Vowel status
+	"diphthongal"
-	"monophthongal"

Figure 4. Means of denoting diphthongization in our Columbus data.

Using these two scales, we scored 131 morphemes containing /æ/ for the country station speaker, and 212 morphemes containing /æ/ for the classical station speaker. Three of the authors individually scored each token (yielding the individual scores refered to later in the paper), and then scored each token together as a group (yielding the group scores). It is the group scores that form the basis for our statistical analyses, and will henceforth be refered to as the *group auditory judgments*. In creating a data matrix from the coded tokens, we included information for each of the internal, independent variables (as described below).

We validated our auditory scales in three ways: (1) comparisons of the group auditory judgements to those of an independent listener; (2) factor analysis and crosstabulations of the individual ratings of the three authors; and (3) correlation of the group auditory judgments with formant measurements.

As the first means of validating our scales, a fourth listener independently scored each realization. We then compared the group auditory judgments for the height scale with the scores of this listener, using a Spearman rank correlation. Results show that for N=343, the correlation coefficient is .4707, with significance at .01. This shows a significant but relatively weak positive correlation between the independent listener's judgments and the group auditory judgments.

In order to compare our judgments on diphthongal/monophthongal character, we crosstabulated the group auditory judgments by the independent listener's judgments. The results indicate 94.4% mutual agreement between the author group and the independent listener for scoring monophthongs,[10] but a 34.2% mutual agreement for scoring diphthongs.[11] Results show a Cramer's V value of .36588 (which gives an indication of the degree of association). Overall, there is a relatively high level of mutual agreement, since the author group and the independent listener agree on the monophthongal/diphthongal nature of 81.6% of the tokens (280 out of a possible 343 realizations).

As a second means of validation, here for our auditory height scale, we conducted factor analyses of the individual ratings of the three authors. Only one factor was extracted. The factor loadings are relatively high, ranging between .85 (Bettina) and .89 (Liz). This indicates that the judgments of the three authors are placed on the same dimension.[12] In other words, the three authors are all utilizing the scale in the same way, which validates the psychological reality of the height scale.

[10]The group auditory judgment categorized 270 tokens as monophthongs out of a possible 343. Out of these 270 tokens, the independent listener agreed that 255 (or, 94.4%) were monophthongs.

[11]The group auditory judgment categorized 73 tokens as diphthongs out of a possible 343. Out of these 73 tokens, the independent listener agreed that 25 (or, 34.2%) were diphthongs. This lower agreement rate for diphthongs may stem from varying notions of what constitutes a diphthong.

[12]However plausible the outcomes of the factor analysis, reliability analyses would be preferred for this step in the validation. We have not yet run these analyses.

In examining our means of rating diphthongization, we crosstabulated the judgments of the individual authors on a pair-wise basis: Bettina vs. Liz, Bettina vs. Steve, and Liz vs. Steve, as shown in Table 1 below.

CELLS: Raw scores		LIZ diph.	LIZ monoph.	LIZ TOTAL	STEVE diph.	STEVE monoph.	STEVE TOTAL
BETTINA	diph.	25	14	**39**	26	13	**39**
	monoph.	71	233	**304**	50	254	**304**
	TOTAL	**96**	**247**	**343**	**76**	**267**	**343**
LIZ	diph.				49	47	**96**
	monoph.		X		27	220	**247**
	TOTAL				**76**	**267**	**343**

Table 1. Results of crosstabulations for diphthongal and monophthongal agreements between the three individual authors, given in raw scores.[13] Results are significant at a level of .01 using a measure of Pearson chi-square probability.

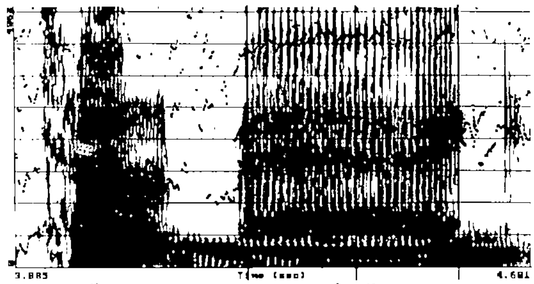
There is strong general agreement between each of the authors regarding the diphthongal/monophthongal nature of the tokens. The highest level of agreement is between Steve and Liz (Cramer's V=.43359, significant at the .01 level from a Pearson chi-square probability). The lowest level of agreement is between Bettina and Liz (Cramer's V=.28813, significant at .01).[14]

As a third means of validation, here involving our tenseness qualifier, we took formant measurements of the *F1* (first formant) and *F2* (second formant) values for each occurrence of /æ/. Using the Kay Elemetrics Computerized Speech Laboratory (CSL) system, each vowel token was first digitized (using a 10 kHz sampling rate) and spectrograms and LPC ("linear predictive coding") formant tracks were then generated, from which the formants were measured. The formants were measured by visual inspection of the spectrograms and LPC formant tracks at three points in each vowel: at or near vowel onset, at a point in the middle of the vowel, and at or near the end of the vowel.

[13] For example, in the first column under diphthongal scores for "Liz" crossed with "Bettina," the number "25" indicates the number of tokens that Liz rated as "diphthongal" which Bettina also rated as "diphthongal." "71" indicates the number of tokens that Liz rated as "diphthongal" which Bettina rated as "monophthongal." And finally, "96" is the total number of tokens rated as "diphthongal" by Liz (out of 343 total.)

[14] The fact that we find the strongest similarity between the authors Liz and Steve is plausible, since they are both L1 speakers of neighboring dialects of American English. The fact that the similarity between Bettina and the other authors is lower is also plausible, since Bettina is an L2 speaker of English and therefore might be using different strategies in the categorization of tokens as monophthongs or diphthongs. These findings seem to provide indirect indication of the reliability of our tenseness qualifier.

The LPC parameters were 14 coefficients, Hamming windowing, and 0.97 preemphasis. (See Figure 5 for a representation of these formant measurements.)



"tote - - - - bag"

Figure 5. Representation of the measurement of *F1* and *F2* values at three points in the /æ/ token. "X's" are placed approximately at locations where the formant measurements were taken from points on the LPC formant track (which is shown as a light-grey trace throughout each formant). (The word represented here is *totebag*, as spoken by "Daniel.")

Vertical bars in the spectrogram in Figure 5 represent the the initial, middle, and end points within each vowel token at which measurements of *F1* and *F2* were taken. These formant measurements were included in our data matrix.

The auditory judgments were then correlated with the mid-values of *F1* and *F2*, as well as the intitial values of *F1* and *F2*, to verify height.[15] Results of correlations indicate that, as expected, height is negatively correlated with initial *F1* (correlation coefficient = -.4776) and mid *F1* (-.2614), and positively correlated with initial *F2* (.4372) and mid *F2* (.5963). Results are significant at a level of .01.

To verify the auditory judgments of the diphthongal nature of the tokens, the judgment scores were correlated with the difference in initial and final measurements (initial *F1* - final *F1*; inital *F2* - final *F2*) and with vowel duration. Results of these correlations are shown in Table 2 below.

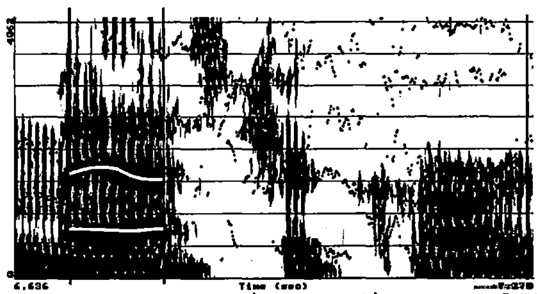
	MEAN		SD		Mean			
	Diph.	Monoph.	Diph.	Monoph.	diff.	t	df	Signif.
F1 diff.	-48 Hz	-22 Hz	126 Hz	289 Hz	26 Hz	.74	336	.461
F2 diff.	169 Hz	33 Hz	365 Hz	282 Hz	137 Hz	-3.43	339	.001
duration	126 ms	105 ms	82 ms	78 ms	22 ms	-2.10	337	.037

Table 2. Results of t-tests for the effect of *F1* and *F2* differences and duration on auditory judgments of diphthongization.

[15]We tested our validated judgments of dependent variables against the independent variables using ANOVA and logistic regression in the SPSS software package, Windows version 6.1.3.

As the results in Table 2 indicate, "*F2* difference" and "duration" are significant. These acoustic measures corroborate our judgments of tensing: the greater the change in *F2* and the greater the duration of the token, the more likely we are to judge it as a diphthong.

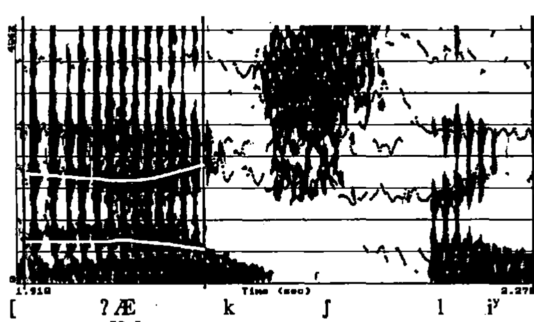
Spectrograms of /æ/ tokens of various heights and tenseness are included in the six figures below to further illustrate the validity of our auditory judgments. Examples from the speech of "Daniel" are given in the first three figures, and examples from the speech of "Red" are given in next three figures. The relevant /æ/ token in each spectrogram is segmented with vertical lines, and white traces are added (following the original LPC traces) to track *F1* and *F2* in these tokens. A loose phonetic transcription and /æ/ token score are provided directly beneath each spectrogram.



[m æ s tʰ ɚ kʰ a ɪ d]
[1-]

Figure 6. Spectrogram of "Daniel" saying *Mastercard,* with /æ/ token rated [1-].

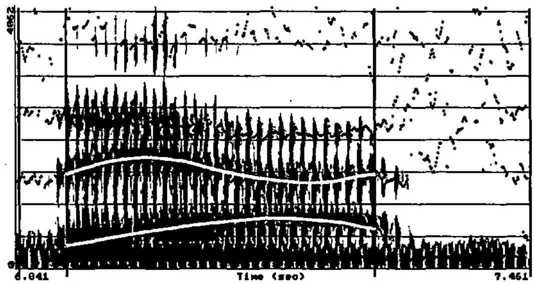
Figure 6, Figure 7, and Figure 8 give spectrograms of tokens produced by "Daniel," our classical station announcer. For "Daniel's" production of the word *Mastercard,* represented in Figure 6, the /æ/ token was scored as [1-], meaning that it received a height score of [1] (approximating /æ/, see Figure 3) and a tensing evaluation of [-], meaning that it was perceived as being monophthongal. Acoustically, the relatively high *F1* and reasonably level formants throughout the vowel give credence to this score.



[ʔÆ k ʃ l iʸ]
[2-]

Figure 7. Spectrogram of "Daniel" saying *actually,* with /æ/ token rated [2-].

Figure 7 is a representation of "Daniel's" production of *actually*, in which the /æ/ token was rated as [2-] by the group. *F1* is slightly lower and *F2* is slightly higher than the formants in the /æ/ token in Figure 6, which is consistent with the higher-rated vowel shown here in Figure 7. Considering that upward movement of *F2* near the end of the vowel is related to coarticulation with the following velar segment (thus the characteristic "velar pinch" of *F2* and *F3*), we might say that formant movement is still consistent with a segment perceived to be monophthongal.

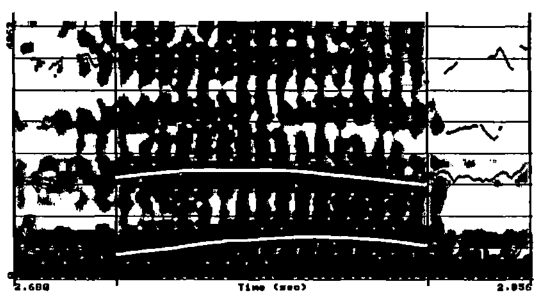


[ð ɛ n]
[3+]

Figure 8. Spectrogram of "Daniel" saying *than*, with /æ/ token rated [3+].

In Figure 8, we see a spectrogram of "Daniel's" production of *than*, which was scored as [3+], meaning that this vowel token was perceived as higher than the vowel in Figure 7, as well as diphthongal. At least from vowel-onset to near the midpoint of the vowel, *F1* is lower than it is in the vowel tokens in the figures above, indicating increased height. The formant movements that are evident in Figure 8 are most likely instrumental in the vowel being perceived as diphthongal.

Figure 9, Figure 10, and Figure 11 give spectrograms of tokens produced by "Red," our country station announcer. One thing to note (and disregard) in these figures are the background music formants that run faintly throughout the spectrograms, which result from "Red's" talking over music during most of his radio show.



[ð æ t]
[1-]

Figure 9. Spectrogram of "Red" saying *that*, with /æ/ token rated [1-].

In Figure 9, "Red's" production of *that* illustrates a vowel token that was scored as [1-]. The formants are relatively stable throughout the vowel, indicating what was perceived as a monophthongal quality, despite the fact that *F1* may seem a bit low to have rendered a score of [1] (indicating no perceived raising of the /æ/ token).

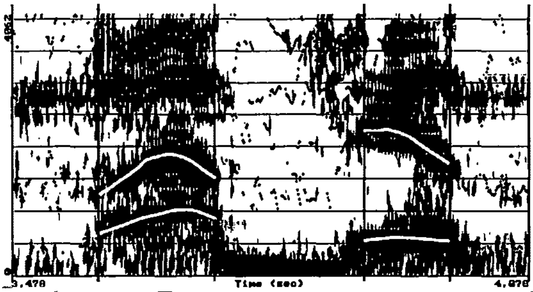


Figure 10. Spectrogram of "Red" saying *last chance*, with the first /æ/ token rated [2+] and the second /æ/ token rated [3+].

Figure 10 offers a good comparison of two /æ/ tokens in different contexts within the same utterance. Both tokens are rated as diphthongal, but the first token (in the word *last*) is scored as [2], one height-level lower than the next token (in the word *chance*), which was scored [3]. *F1* and *F2* in these two tokens seem to vary accordingly: *F1* is higher and *F2* is lower in the vowel that is perceived as being lower, and *F1* is lower with *F2* higher in the vowel that is perceived as higher. This figure also illustrates the tendancy for previous liquids to restrict /æ/-raising (as in *last*) and following nasals to positively affect /æ/-raising (as in *chance*), as will be discussed in the Findings section later in the paper.

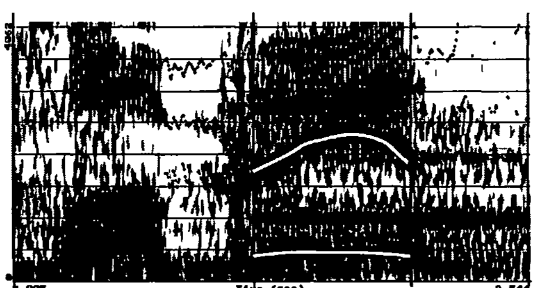


Figure 11. Spectrogram of "Red" saying *Club Dance*, with /æ/ token rated [4+].

Finally, Figure 11 shows a spectrogram of "Red's" production of the term *Club*

Dance, a frequent utterance during his promotions of night club activity in Columbus. The high realization of this token, scored [4+], is typical of /æ/ tokens followed by nasal segments in "Red's" speech.

Vowel Spaces and the Interaction of Height and Tenseness of /æ/

The distributions of tokens of /æ/ for each of the speakers are shown in Figure 12 and Figure 13 below. The general vowel space is delimited by anchor tokens of /i/ and /u/, with the addition of the rated /æ/ tokens. Individual tokens of /æ/ are marked on the figures using the phonetic symbols which we use to represent each vowel height in our scale, as shown in Figure 3. An exception to this is our usage of the symbol "a" in the figures below to represent "Æ" *capital ash* of Figure 3, due to limitations in our plotting software. Ellipses enclose 95% of the data points for each vowel height category. These ellipses are the result of a principal components analysis of variation for each vowel height category, on which two standard deviations are then calculated.[16] It should be clear from these figures that raising takes place in the speech of both Red and Daniel, but there is greater range of variation in the height of Red's /æ/ tokens. Red's *F1* measurements vary from about 400 Hz to 1000 Hz, while Daniel's measurements vary from about 300 Hz to 800 Hz. In terms of *F2*, Red shows variation from 1300 Hz to 2700 Hz, and Daniel shows variation from 1300 Hz to 2100 Hz.

The distributions of tokens of /æ/ for each of the speakers, as well as sample representations of /i/ and /u/ from the data, are shown in Figure 12 and Figure 13 on the following page.[17]

[16]The "principal components" of the data clouds for each vowel height category are two regression "lines" through each cloud at 90° angles to each other. These right-angle lines then become the axes for which the standard deviations are found for the category.

[17]Interesting to note in these vowel spaces (though not relevant to the present study) is the greater acoustic variability of /u/ than /i/, especially evident in the representative vowel space of "Red." In general, the greater front-back "displacement" of /u/ is due in part to contextual variation; a following front consonant will cause /u/ to be fronted, while a following back consonant will cause /u/ to be backed, effects which are evident in the acoustics of the vowel in these different environments. The vowel /i/, however, is much more resistant to contextual influence since it is produced with a high degree of tongue bracing against the walls of the mouth (Fujimura & Kakita, 1975). This bracing tends to stabilize /i/ against the level of perturbation due to contextual influence which can be seen in /u/.

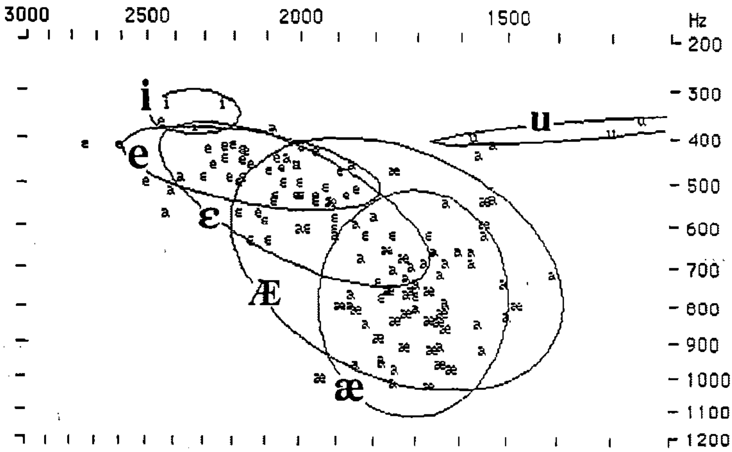


Figure 12. Vowel space of country station announcer "Red."

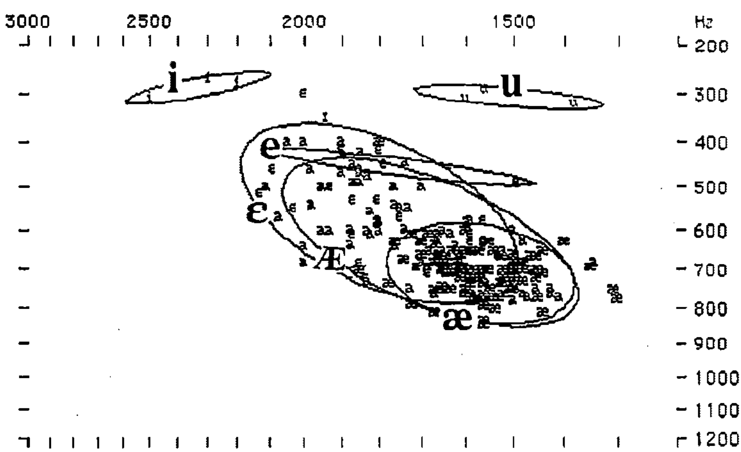


Figure 13. Vowel space of classical station announcer "Daniel."[18]

[18]Note the single token of [ɪ] that is plotted in "Daniel's" vowel space, with an $F1$ of approximately 350 Hz, and an $F2$ of approximately 1950 Hz. This /æ/ token was produced in the word *thank*. Since this was the only token in our data to be rated [ɪ] (i.e., scored [5] according to our height scale in Figure 3), it is not included in an ellipse.

Analysis of our two dependent variables height and tenseness (the latter indicated by diphthongization) show that they interact. As vowel height increases, the percentage of diphthongs increases for each height category. That is, the more a token of /æ/ is raised, the more likely it is to also be tensed. (See Table 3 below.) So, for example, only 10.9% of unraised tokens of /æ/ are diphthongized, whereas 19.1% of tokens raised to the next height ([Æ]) are diphthongized, 22.2% of tokens raised to [ε] are diphthongized, and finally, 76.9% of tokens raised to [e] are diphthongized.

	Count Row Pct Col Pct	DIPHTONS diphthon giz d	monophth ong m	Row Total
HEIGHT				
	1	12	98	110
ae		10.9	89.1	32.1
		16.4	36.3	
	2	29	123	152
AE		19.1	80.9	44.3
		39.7	45.6	
	3	12	42	54
E		22.2	77.8	15.7
		16.4	15.6	
	4	20	6	26
e		76.9	23.1	7.6
		27.4	2.2	
	5		1	1
I			100.0	.3
			.4	
	Column	73	270	343
	Total	21.3	78.7	100.0

Table 3. Crosstabulation of Height by Diphthongization / Monophthongization for group auditory judgments of both speakers' data.

These data suggest that tensing and raising of /æ/ are not independent phenomena in central Ohio (but see the discussions of the factor groups "proximity to right-hand word boundary" and "stress" below).

Selection of Independent Variables for the Study of /æ/ Variation

A preliminary auditory analysis of tokens of /æ/ and /a/ in the recorded data from our two speakers revealed a high degree of variablity in the tokens of /æ/ and very little in the tokens of /a/. For this reason, we focused our study to an examination of /æ/ raising and tensing phenomena. We leave investigation of the possible variation in /a/ to a future study.

Since our study includes speech data from only two individuals within an audience design framework, we do not factor in social characteristics of the individuals. We selected only two external (social) independent variables to investigate. (These factors were introduced above in the subsections "The Corpus: Radio Speech" and "Data Collection," and are briefly discussed below.)

EXTERNAL FACTOR GROUPS FOR THE TENSING AND RAISING OF /æ/

1. socioeconomic status (SES), defined by station
    - classical station (reflecting a relatively higher average SES with respect to the country station)
    - country station (reflecting a relatively lower average SES with respect to the classical station)
2. style
    - monologue
    - dialogue

A review of previous research on similar vowel shifts led us to select the following internal (linguistic) independent variables for our study of /æ/ (see discussion of each of these variables below):

INTERNAL FACTOR GROUPS FOR THE TENSING AND RAISING OF /æ/

1. membership in *mad, bad, glad* lexical class
    - belong to class
    - end in *-ad* but are not *mad, bad, glad*
    - other
2. grammatical category
    - preterite strong verb
    - preterite irregular verb
    - preterite regular (weak) verb
    - other verbs (non-preterite)
    - non-verb
3. right-hand morphological boundary
    - word
    - Class 1 suffix[19]
    - Class 2 suffix
    - inflectional suffix
4. proximity to right-hand word boundary, measured in terms of syllables
5. stress
    - stressed monosyllabic word
    - primary
    - secondary
6. preceding phonetic segment(s) (in the case of a morpheme-internal cluster, all segments of the cluster were noted)
7. following phonetic segment
8. syllable membership of the following consonant
    - following consonant(s) in the same syllable ("tautosyllabic")
    - following consonant shared with the next syllable ("ambisyllabic")[20]

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[19]From O'Grady, et al. (1997:132-3): "it is common to distinguish between two types of derivational affixes in English. Class 1 affixes are characterized by the fact that they often trigger changes in the consonant or vowel segments of the base and may affect the assignment of stress [e.g., *-ity, -ive, -ize, -ion*]. (Class 1 affixes often combine with bound roots.) In contrast, Class 2 affixes tend to be phonologically neutral, having no effect on the segmental makeup of the base or on stress assignment [e.g., *-ness, -ful, -ly, -ish*]."

[20]On phonetic grounds alone, it seems impossible to decide whether the consonant following /æ/ in words such as *planet, flannel, personality,* and *California* is ambisyllabic, or instead falls in the onset of the following syllable. At least in the lexical representation, lax vowels are not allowed in open position in English (or in other Germanic languages such as Dutch and German, for that matter).

Regarding the external (social) independent variable of socioeconomic status (SES), we might expect that the speakers' socioeconomic background would have an effect on the extent of participation in the NCS. Hock & Joseph claim that the Chicago Chain Shift (a subsystem of the NCS) is limited to certain white working-class male groups (Hock & Joseph, 1996:327). In contrast to this generalization, Labov cites Eckert's study in a suburban Detroit high school in which she showed that "the shift was most advanced among females of the upwardly mobile segment of the high school population" (Labov, 1994:189). A more recent study by Eckert & McConnell-Ginet (1995:502-3) found that for later stages in the NCS (i.e., shifts 5 and 6 in Figure 2), it is the groups associated with lower SES who lead in the change.

The idea underlying the selection of the style variants "monologue" (scripted speech) and "dialogue" (spontaneous speech) is that in a dialogue, the amount of attention paid to the speech itself will generally be somewhat less than in monologue speech. In the Labovian definition of style, the relative amount of attention paid to speech plays a central role in the level of formality exhibited in that speech (cf. Labov 1972, Chapt. 3).[21]

The first two linguistic factor groups (grammatical category and membership in *mad, bad, glad* lexical class) were studied to determine whether or not the Columbus dialect shares the lexicalization which has occurred in the Philadelphia dialect. Philadelphia, like Columbus, is classified in the Lower North dialect region (see Wolfram, 1991:85, citing Carver) and is not considered to be participating in the NCS. Thus, Philadelphia offers a reasonable alternate model for Columbus speakers. According to Labov, "[in Philadelphia] all vowels followed by voiced stops are lax, except for those of *mad, bad,* and *glad,* which are always tense" (Labov, 1994:431). To test whether this lexical category operates in the same fashion in Columbus, we coded the tokens for membership in the *mad, bad, glad* class. The variant "other *-ad* word" is included to test for lexical diffusion effects of /æ/ raising on similar words, such as may be taking place with *sad* in Philadelphia (Labov, 1994:431).

Regarding grammatical category, preterite forms of strong verbs ending in nasals, e.g., *ran, swam, began,* show neither tensing nor raising of /æ/ in Philadelphia (Labov, 1994:431; cf. Halle & Mohanan, 1985:107). To determine whether this factor is operational in the Columbus dialect, we coded the data for the following five variants: preterite strong verb, preterite irregular verb,[22] preterite regular (weak) verb, other verbs (non-preterite), and non-verbs.

In the selection of the linguistic variables, we also consider morphological structure to determine whether or not raising and tensing of /æ/ are postlexical processes. Data from Trager (1930)[23] and Halle & Mohanan (1985: 75) suggest that morphological structure is irrelevant for these processes. Halle & Mohanan give the following rule for the realization of /æ/ ("/æ/-Tensing") in "some GA [American English] dialects," as shown in Figure 14. According to Halle & Monahan (pp. 84, 101), this rule operates postlexically, and therefore is not affected by morphological structure.

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[21]Strict adherence to Bell's theory of audience design suggests an opposite hypothesis: all radio speech is addressed to the mass target listening audience, resulting in little difference between "monologue" and "dialogue."

[22]Our data yielded no examples of preterite irregular verbs.

[23]Trager's data pertain to Mid-Atlantic states dialects.

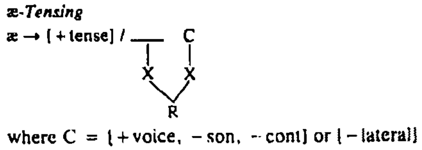

Figure 14. /æ/-Tensing (adapted from Halle & Monahan, 1985:75).

In Kiparsky's (1988) view, however, /æ/ tensing is more complex in several respects. Whereas tensing is restricted to members of lexical categories and applies to the lexical component in Philadelphia and more generally in the Mid-Atlantic area, it is a variable postlexical rule in the Midwest. In Midwestern dialects, the opposition between /æ/ and /a/ "is neutralized in favor of *a* before tautosyllabic *r* by the lexical backing rule" (see Figure 15 below) (402).

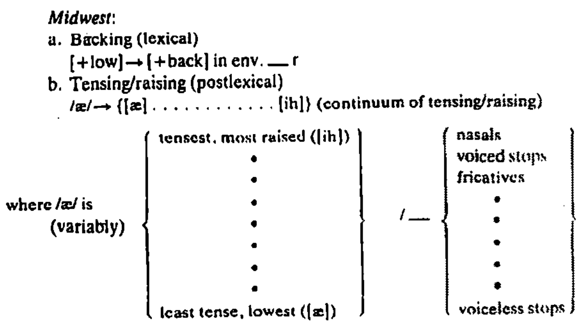

Figure 15. Lexical and postlexical rules for /æ/ change in Midwestern dialects (adapted from Kiparsky, 1988:402).

In connection with what Kiparsky refers to as a "continuum of tensing/raising," it is worth pointing out that in more extreme cases, the tensing and raising of /æ/ can, e.g., result in a realization of *Ann* which is homophonous with *Ian* (Hock & Joseph, 1996:134). As Kiparsky shows, yet another situation exists in New England, which falls diachronically and phonologically between the situations in the Midwestern and the Mid-Atlantic dialect regions. For the Mid-Atlantic dialects, Kiparsky's analysis is strongly supported by data and analyses presented in Labov 1994 (Chapts. 15-18).

Our selection of the right-hand morphological boundary as an independent variable is meant to test Kiparsky's analysis. Blindness for morphological structure is a feature of most postlexical processes. Therefore, we would predict that if tensing and raising of /æ/ is postlexical, the morphological structure should have no effect on tensing and raising.

Proximity to the right-hand word boundary (measured in terms of syllables) is an additional factor that we considered. The inclusion of this factor group is motivated by the notion that the duration of a given prosodic unit (e.g., syllables, feet) within a word may be related to the length (in syllables) of that word. Perhaps the vowel /æ/ will have a shorter duration the further it is from the end of the word, i.e., the greater the number of syllables that follow it before the word boundary. For example, in the nouns *man*, *mantle*, and *manifold*, all three instantiations of /æ/ occur within the same phonetic environment, yet we might expect that the vowels will have differenct durations: /æ/ in *man* would have the longest duration, while the /æ/ in *manifold* would have the shortest.

An additional factor we considered is stress. Stress has several acoustic correlates, including amplitude, duration, and pitch. The tensing and raising of /æ/ is clearly related to stress; witness the difference in (1) between the realizations of stressed and unstressed /æ/ in the following tokens from our data, where the vowel raises only when it is stressed (primary stress is indicated with an acute accent):

(1)	"ánalyze"	[eᵊ] n [ə] lyse
	"análysis"	[ə] n [Æ] lysis

From this, it seems that the tensing and raising is confined to non-'weak', i.e., non-cliticized words (Labov, 1994:430). As suggested in (1), for polysyllabic words, tensing and raising seem to be restricted to syllables headed by a non-degenerate foot.

Preceding and following phonetic segments have also been shown to affect /æ/ movement. Studies have shown that for both the Mid-Atlantic and Midwestern dialects, there is cross-dialectal variation in the tensing and raising of /æ/ depending on the nature of the following consonant. Labov (1994:430) discusses the considerable differences between the vowel system in New York City and the more restricted Philadelphia system. An example of a phonetically restricted system regarding /æ/ raising can be found in Milwaukee (Chambers, 1995:198-200). According to Chambers, in this dialect the tensing and raising of /æ/ occurs preceding voiced velar segments /g, ŋ/, e.g., *bag* /bæg/ becomes something similar to [beg]. One of the authors, a native of the upper Midwest, notes that this phenomenon is widespread throughout Minnesota and Wisconsin.

Additional studies on the NCS have shown that other preceding and following phonetic segments condition the vowel shift in question. For example, Labov (1994) notes that preceding liquids and following nasals have a significant effect on tensing and raising of /æ/. We will pay particular attention to these environments (preceding liquids and following nasals) in this study, although we coded all preceding and following segments.

Finally, we investigate syllable membership of the consonant following /æ/, because it also has been shown to have an effect on vowel tensing. Labov (1994:432) found an unpredictable distribution of /æ/ tensing in words such as *planet* and *personality*, where it is unclear whether the consonant following /æ/ is ambisyllabic or wholly in the onset of the next syllable (see Footnote 20).

Statistical Methods

For the sociolinguistic aspects of this study, we employ the statistical methods logistic regression and ANOVA, rather than the commonly-used VARBRUL, a statistical technique which is popular among North American sociolinguists. Generally, logistic regression, with which we analyse the tensing (diphthongization/monophthongization) of /æ/, is very similar to VARBRUL. Like VARBRUL, logistic regression has been created for nominal dependent variables, i.e., "discrete choices" (Sankoff, 1987:984). The main advantage of logistic regression is that it makes it easy to analyse the interactions between independent variables; this is very laborious in VARBRUL, and the outcomes are somewhat opaque. Statistics were performed using the SPSS statistical software package for Windows 6.1.3.

FINDINGS: SOCIOLINGUISTIC ANALYSES OF THE TENSING AND RAISING OF /æ/

Analysis of our auditory judgments indicated that /æ/ is variably tensed and raised within the speech of our two speakers. Since we are working within the framework of audience design, we claim that this phenomenon directly reflects the speech of the central Ohio community. That we find /æ/ raising, the initial shift in the NCS, suggests that central Ohio speakers may be participating in the NCS. Alternatively, this /æ/ tensing and raising may be an isolated phenomenon which merely resembles the initial shift in the NCS.

Our auditory judgments of /a/ tokens indicated that this vowel is not undergoing any significant fronting.[24] This dependent variable was included to confirm participation in the NCS, since it is a shift that is unique to the NCS. Lacking evidence for the fronting of /a/, we must conclude that the data gathered thus far are inconclusive for central Ohio's participation in the NCS. They could, however, be evidence of the NCS in its infancy in this area.

Factor Group Effects on the Tensing and Raising of /æ/

We now procede to examine each of the factor group's effects on /æ/ raising and tensing. As was mentioned above, in our analyses of the dependent variable, raising was measured via the height of the vowel (on a five-point scale), and tensing was determined via categorization of the vowel as either diphthongal or monophghthongal (a nominal variable[25]). Table 4 on the following page summarizes the effect of each factor group on raising and tensing (diphthongization): those that are significant are marked "+", and those that are not significant are marked "-." The statistical analyses which yielded these outcomes were analyses of variances (ANOVAs) for raising, and logistic regression for tensing.

Factor groups which were found to be significant for the raising of /æ/ were socioeconomic status (SES), proximity to the right-hand word boundary, stress, preceding liquid segment, following nasal segment, and syllable membership of the following consonant.

Factor groups which were found to be significant for the tensing of /æ/ were SES, preceding liquid segment, following nasal segment, and syllable membership of the following consonant. There was also a significant interaction effect for tensing between SES and style.

The factor "style" (*monologue* versus *dialogue*) does not have a significant effect on the tensing of /æ/, nor on its raising. This negative finding may be due to the relatively low number of observations of dialogue speech (N=39). It may also serve as confirmation of Bell's audience design theory, which predicts little style shifting in radio speech (see Footnote 21).

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[24] Instead, /a/ has a small number of slightly-backed variants. This reflects the incomplete merger of the categories /a/ and /ɔ/ (e.g., *cot* and *caught*) in central Ohio and many other parts of the nation. We do not analyze this phenomenon in this study.

[25] A *nominal variable* is a factor which has discrete categories; in this case, our variable "Tenseness" has the categories "diphthong" and "monophthong."

	raising	tensing
EXTERNAL FACTORS		
main effects		
SES (defined by station)	+	+
style (monologue/dialogue)	-	-
interaction effect		
SES and style	-	+
INTERNAL FACTORS		
main effects		
membership in *mad, bad, glad* lexical class	-	-
grammatical category	-	-
right-hand morphological boundary	-	-
proximity to right-hand word boundary	+	-
stress	+	-
preceding liquid segment	+	+
following nasal segment	+	+
syllable membership of the following consonant	+	+

Table 4. The presence ("+") and absence ("-") of significant effects of internal and external factors on the raising and tensing of /æ/ in Columbus.

Interestingly, SES and style exercise a significant interaction effect on the tensing of /æ/, but not on the raising of /æ/. Consider Table 5 below:

	Monologue				Dialogue			
	country		classical		country		classical	
monophthong	71	69.6%	170	84.2%	20	69.0%	9	90.0%
diphthong	31	30.4%	32	15.8%	9	31.0%	1	10.0%
TOTALS	102	100%	202	100%	29	100%	10	100%

Table 5. The interaction effect of style and SES on the tensing of of /æ/. Raw scores and column percentages are shown.

For the country station speaker, the percentage of diphthongs changes minimally between monologue (30.4%) and dialogue speech (31.0%). For the classical station speaker, however, it changes much more (monologue 15.8%; dialogue 10.0%). Remarkably, for the classical station speaker, the proportion of diphthongs decreases going from monologue to dialogue speech, which is opposite the expected effect of greater tensing in casual speech. It should be kept in mind, however, that for the dialogue speech by the classical station speaker, we are generalizing over very few observations (N=10), so the latter effect may well be merely an artefact of the low count.

Neither of the two linguistic factor groups that were used to test Columbus's resemblance to Philadelphia in terms of lexicalization of /æ/ raising and tensing (membership in *mad, bad, glad* lexical class, and grammatical category) has a significant effect on our Columbus data. If these findings are generalizable, then it can be concluded that in Columbus, the tensing and raising of /æ/ has not been lexicalized as it has in Philadelphia.

The latter conclusion is confirmed by the finding that the nature of the nearest following morphological boundary (i.e., /æ/ preceding a Class 1 suffix, /æ/ preceding a Class 2 suffix, /æ/ preceding an inflectional suffix, /æ/ preceding a word boundary) has no meaningful effect on the tensing and raising of /æ/ in our data. The fact that /æ/ raising and tensing appears to be blind to morphological structure suggests that these are postlexical processes.

The number of syllables[26] between /æ/ and the right-hand word boundary has a significant effect on the raising of the vowel. Both qualitatively and quantitatively, raising is inversely proportional to the number of following syllables, i.e., the greater the number of syllables following /æ/, the less likely it is that /æ/ will be raised, and if it is, it will be raised to a lesser degree. Tensing is not sensitive to this variable.

The same overall pattern is found for the next prosodic dimension, word stress. Both qualitatively and quantitatively, raising occurs most in monosyllabic words (e.g., *man*), somewhat less in syllables with primary stress (e.g., *manifold*), and is least likely to occur under secondary stress (e.g., *manifesto*). Example (2) below shows the average height for /æ/ in syllables of each of these stress types, as occurred in our Columbus data. (Primary stress is marked with an accute accent mark, and secondary stress is marked with a grave accent mark.)

(2) Stress	Example word	Avg. height for stress-type[27]
monosyllabic word	*man*	2.19
primary stress	*mánifòld*	1.83
secondary stress	*mànifésto*	1.55

Although overall stress does not have a significant effect on tensing, there is a significant difference in tensing between monosyllabic words and syllables with secondary stress (/æ/ diphthongizes in 24.9% of monosyllabic words and in only 5.0% of syllables with secondary stress, with B=.7230, SE=.3637, Wald=3.8680, df=1, signif.=.0492, R=.0725, and Exp(B)=2.0606).[28] The fact that the two factor groups "proximity to right-hand word boundary" and "stress" have a significant effect only on raising suggests that the tensing and raising of /æ/ are mutually independent (insofar as the auditory analyses are reliable and the present findings are generalizable). This might be unexpected, due to the

[26]The number of syllables separating the /æ/-containing syllable from the right-hand word boundary is the only *continuous* independent linguistic variable in our set.

[27]"Average height" refers to the average of the scores for height that the /æ/ tokens of this stress-type received, based on the 5-point height scale in Figure 3. A score of "1" indicates no raising; the higher the score, the more raised the token of /æ/ is.

[28]The statistic "B" is the factor weight (the regression coefficient). "Wald" is a statistic with which the significance of the regression coefficient is determined; it has a chi-square distribution. "Exp(B)" is a logistic function, in particular the power to which *e* must be raised to obtain the exponential function.

observations noted above in Table 3, which showed that height and tenseness, as dependent variables, do interact.

We studied both the left-hand and right-hand segmental environments. Both turn out to have significant effects on the raising and the tensing of /æ/. Regarding the left-hand environment, a liquid causes significantly less raising as well as less tensing than any other (natural class of) consonant. Conversely, a following nasal triggers significantly more raising and tensing than any other consonant. As Hock & Joseph (1996:134) summarize, the Northern Cities realization of /æ/ tends to be strongly nasalized (at least when followed by a nasal segment). In this respect, the Columbus dialect again resembles those spoken in cities participating in the NCS. Preceding /l/ is a relatively disfavoring environment for /æ/ raising and tensing in the NCS (Labov, 1994:458). We found this environment to have the same effect in our data. Interestingly, the dimensions "liquid versus other consonant preceding" and "nasal versus oral consonant following" are among the independent linguistic variables that turned out to have strong effects on the tensing and raising of /æ/ in Philadelphia, which is not in the NCS (Labov, 1994:512).

Although we do not further investigate the effects of left-hand and right-hand segmental environments, our data would permit testing for such potentially relevant factor groups. For example, we are in a position to test the claims regarding the conditioning right-hand environment for the tensing of /æ/ in Halle & Mohanan's analysis (reproduced in Figure 14 above). However, even a superficial inspection of the relevant crosstabulations (not presented here) makes it clear that in our data there are no (classes of) consonants before which the tensing and raising of /æ/ is blocked.

The last linguistic dimension studied in connection with the tensing and raising of /æ/, the syllable membership of the following consonant, turns out to have a significant effect on both tensing and raising. In connection with the syllable membership of the following consonant, we distinguished four conditions as follows. The following consonant is:

- either ambisyllabic or part of the onset of the next syllable;
- one tautosyllabic consonant;
- two tautosyllabic consonants; or
- three tautosyllabic consonants

The relative importance of these four conditions is not entirely identical for raising versus tensing. For raising, the ordering of importance is:

	3 tautosyll. C >	1 tautosyll. C >	2 tautosyll. C >	ambisyll./next syll.
average height:	3.24	2.02	1.92	1.66

while for tensing, the ordering of importance is:

	3 tautosyll. C >	2 tautosyll. C >	1 tautosyll. C >	ambisyll./next syll.
percent diphth.:	66.7 %	23.3 %	19.3 %	11.0 %

Although both the strongest and the weakest effects in both dimensions are related to the same factors, for this factor group (which is related to syllable weight) the raising and the tensing of /æ/ are not entirely identical in their conditioning.

Relative Weight of Factor Group Effects for the Tensing and Raising of /æ/

Finally, we examine the relative importance of the eight independent linguistic variables to the raising and tensing of /æ/. We investigate which variables play the most meaningful role on the overall extent of raising and tensing, as well as their weights.

To establish the most important factors for raising, we ran a multiple regression analysis.[29] The main outcomes are presented in Table 6.[30]

variable	B	SE B	Beta	t	signif.	MR	R^2
-/+nasal foll.	1.2224	.0751	.6475	16.282	.0000	.6836	.4673
stress	.2462	.0592	.1655	4.161	.0000		
constant	-.2545	.1726		-1.475	.1413		
	F=149.1551		df=2,340		signif.=.0000		

Table 6. Findings from multiple regression analysis regarding the internal factors most important for raising. Factor groups entered into the analysis included the eight internal factors listed both in the section "Selection of Independent Variables" and Table 4.

The nasal/oral nature of the following consonant turns out to be the main predictor for the raising of /æ/. The nature of this effect is, as discussed above, that significantly more raising of /æ/ occurs preceding a nasal. The second and only other significant predictor is word stress. The relationship between stress and raising in this multiple regression equation is positive: stressed monosyllables induce the most raising, syllables with primary stress induce less raising, and syllables with secondary stress induce the least raising (see Example (2)).

These two significant factor groups together accont for 47% (R^2) of the variance in the height of /æ/ in the data for these two speakers.

To establish the most important factors for tensing, we applied logistic regression[31] to our data, with all eight internal factors groups as predictors (in view of the nominal nature of this variable, logistic regression is most appropriate method). The most important outcomes can be found in Table 7.

[29]With forward inclusion. At each step, the criterion for a variable to be entered is for its F-to-enter to have a probability smaller than .05, while a variable with a probability greater than .10 is removed.

[30]"Beta" is the weight of the independent variable that goes into the equation for the standard scores (the "z-scores") of the dependent variable. (In the equation with z-scores, the intercept , or the constant, is zero.) "F" indicates the overall goodness of fit for this analysis.

[31] With forward inclusion. At each step, the criterion for a variable to be entered is for its score statistic to have a probability smaller than .05, while a variable whose likelihood ratio has a probability greater than or equal to .10 is removed.

	chi-square	df	sign
-2 log likelihood	317.367		
model chi-square	37.761	4	.0000
goodness of fit	341.142		

variable	B	SE	Wald	df	sign	R	Exp(B)
-/+nasal follows	.5138	.1488	11.9244	1	.0006	.1672	1.6716
syll.membership foll. C			11.2008	3	.0107	.1210	
1 vs.3 tautosyll.C's	.3028	.2232	1.8413	1	.1748	.0000	1.3537
2 vs.3 tautosyll.C's	.1516	.2649	.3275	1	.5672	.0000	1.1637
ambisyll./next syll.vs 3 tautosyll C's	.7955	.3289	5.8494	1	.0156	.1041	2.2156
constant	1.0169	.1740	34.1706	1	.0000		

Table 7. Findings from logistic regression analysis regarding the internal factors most important for tensing. Factor groups entered into the analysis included the eight internal factors listed both in the section "Selection of Independent Variables" and Table 4.

In the displays above, "B" is indicative of the factor weight. For the factor group "syllable membership of the following consonant," the contrast between a situation in which the following consonant is ambisyllabic versus one in which /æ/ is followed by three tautosyllabic consonants does have a highly significant effect on the diphthongization of /æ/. For that reason the factor group does as well. This is true in spite of the fact that the two contrasts within this factor group which have the smallest weights (namely one versus three tautosyllabic consonants, and two versus three tautosyllabic consonants) do not play a significant role in the diphthongization of /æ/.

The overall outcome of this analysis is that only two out of the eight internal factors have a meaningful effect on the diphthongization of /æ/: following nasal segment and syllable membership of the following consonant. Both are properties of the following consonant, the first one regarding the oral versus nasal nature of the segment and the second one regarding syllable membership.

A striking aspect of the findings for the multiple regression (height, i.e., raising) and the logistic regression (diphthongization, i.e., tensing) is the fact that the oral/nasal nature of the following consonant emerges as the main predictor for both dimensions in the process of the tensing and raising of /æ/. A better understanding of the process of coarticulation of vowels with following nasals might be instrumental in explaining this finding.

The only other significant predictor emerging from the analysis of raising is stress. Regarding tensing, the only other significant predictor selected is syllable membership of the following consonant. These two factors are not identical, but they are not entirely unrelated either, as both stress and relative syllable membership pertain to prosodic organization.

QUESTIONS FOR FUTURE RESEARCH

This pilot study leaves many interesting questions for future research, most of which can be addressed through further examination of our current corpus, requiring no further data collection.

In terms of internal factor groups, the effects of the preceding and following phonetic segments can be explored in much greater detail. For example, for some central Ohio speakers, a following palatal segment will have the effect of tensing (and, in some cases, raising) an otherwise lax vowel, e.g., *crash* becomes [kɹeʃ], *treasure* becomes [tɹeʒɚ], *fish* becomes [fiʃ], and *bush* becomes [buʃ]. We might explore the extent to which preceding or following palatals have a favoring effect on the the tensing and raising of /æ/. More generally, what is the effect of place of articulation on tensing and raising? Is it comparable to Labov's finding that following palatal and apical segments favor raising, whereas following labial and velar segments disfavor raising in the NCS (1994:458-9)? Does the voice specification of the preceding or following consonant have a systematic effect on tensing and raising? Does a preceding single consonant versus a preceding consonant cluster have an effect? And what about the sonority value of the following consonant?

Another question to be addressed in further research is whether or not the linguistic factor groups we studied are mutually independent. In other words, do their *interactions* exert any significant effects on the raising and the tensing of /æ/? In particular, we would be interested in the effect of the following interactions:

- between the factor group "number of syllables to the right-hand word boundary" and the factor group "stress"
- between the factor group "number of syllables to the right-hand word boundary" and the factor group "syllable membership of the following consonant"
- between the factor group "stress" and the factor group "syllable membership of the following consonant"
- between the factor group "liquid versus other consonants preceding" and the factor group "nasal versus other consonants following"

The interaction effects can be studied for raising (using ANOVA) as well as for tensing (using logistic regression).

For both the analyses of the main effects and for the analyses of the interaction effects, it would be preferable to treat the linguistic conditions underlying each internal factor group as "repeated measure(ment)s." This refinement will be implemented in the next stage of our research.

If we are to observe the spread of the NCS or any other sound change through the lexicon of central Ohio speakers, then lexical frequency effects could also be examined. While we may expect frequency effects to have the most impact on deletion or reduction processes, we do not want to rule out their effect on vowel tensing without further study. Frequently-used lexical items might tend to incorporate vowel changes first. On the other hand, unshifted vowels in these same high-frequency lexical items may serve as important sociolinguistic markers of group identity, and therefore be more resistant to change. In studying this factor, we would need to make a clear differentiation between lexical frequency defined generally and lexical frequency as an artefact of our data. For example, the phrase *Club Dance* has high frequency in "Red's" promotional banter, and the word *Mastercard* appears frequently throughout "Daniel's" fund-raising appeals. Neither of these phrases occurs frequently in the general lexicon.

Other studies clearly indicate that socioeconomic status can interact with gender (e.g., Eckert, 1986; Eckert & McConnell-Ginet, 1995; Hock & Joseph, 1996:327). In a future study, we hope to include speech from female speakers.[32]

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[32]The choice of male radio announcers in this pilot study was driven by the fact that we were unable to identify any female announcers who were natives of central Ohio.

Refinements in our instrumental analysis of vowel tensing and raising are also in order. A more accurate characterization of the nature of diphthongs will require a more precise methodology for measuring formant movement throughout the vowel. For example, we must consider the placement and slope of formant changes within vowels.

Since our auditory and acoustic analyses are based on radio-broadcast speech, we might wonder whether this form of sound transmission has any systematic distortion effect on the acoustic signal. In other words, how suitable is radio speech for acoustic analysis? We could attempt to assess whether or not the acoustics of natural speech vary significantly from radio broadcast speech by comparing laboratory recordings of both speakers' speech to our radio tape-recordings.

On the basis of some of the aspects of the present study, a larger scale sociolinguistic study of possible shifts in the Columbus vowel system could be designed, based partly or not at all on radio speech. This follow-up study could include analysis of the other vowels which make up the NCS. In particular, /a/ merits further attention. Our current study revealed little fronting of /a/, but perhaps any subtle movement occurring could be better detected by more careful instrumental measures. Any study of the shift of /a/ must also take into account the collapse of /a/ and /ɔ/, a merger which divides Ohio from southwest to northeast, roughly along Interstate 71, which runs directly through Columbus. In this merger, the vowels in pairs such as *Don* and *dawn,* and *cot* and *caught* are pronounced the same by speakers southeast of this dividing line (Labov, 1996). If the /a/-fronting from the NCS takes hold in central Ohio (an area where the merger has uncertain status), to what extent will it impact words such as *cot* and *caught* in the same way?

CONCLUSIONS

This pilot study yields the following provisory conclusions.

In the central Ohio dialect, the vowel /æ/ shows variation in tensing and raising simliar to the Northern Cities Shift. However, the vowel /a/ is not fronted as it is in the NCS. Thus, we cannot state conclusively that the variation of /æ/ observed in our data indicates participation in the NCS.

The study of the external conditioning factors (SES and style) show that the tensing and raising of /æ/ is socioeconomically stratified, occuring to a greater extent in the speech of speakers of relatively lower SES. However, the available data do not to allow any conclusions as to the stylistic conditioning of the process.

The study of the internal conditioning factors showed that tensing of /æ/ and raising of /æ/ are related but not mutually dependent. The nasal/oral nature of the following consonant is the factor with the strongest influence on both the raising and the tensing of /æ/. Secondary factors are prosodic in nature: stress (for raising) and syllable membership of following consonants (for tensing). The tensing and raising of /ae/ probably apply postlexically.

As these results indicate, there is considerable externally- and internally-influenced variation in the production of /æ/ for Columbus speakers. Further study of the vowel systems of central Ohio speakers will shed additional light on the status of their dialects, and the relationship of the variation in their vowel systems to the vowel shifts taking place in neighboring dialects.

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